

We claim:

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 1. A computing system for executing groups of individual instructions in parallel by processing pipelines, the system comprising:

storage means for holding at least one group of instructions to be executed in parallel, each instruction in the group having associated therewith a pipeline identifier indicative of the pipeline for executing that instruction and a group identifier indicative of the group of instructions to be executed in parallel;

means responsive to the group identifier for causing all instructions having the same group identifier to be executed at the same time; and

means responsive to the pipeline identifier of the individual instructions in the group to supply each instruction in the group to be executed in parallel to an appropriate pipeline.

2. A computing system as in claim 1 wherein the storage means includes the at least one group of instructions, and for each instruction the storage means includes the group identifier and the pipeline identifier.

3. A computing system as in claim 2 wherein each instruction in the at least one group of instructions has associated therewith a different pipeline identifier.

4. A computing system as in claim 1 wherein the storage means holds at least two groups of instructions, and all of the instructions in each group having associated therewith a common group identifier are placed adjacent to each other in the storage means.

5. A computing system as in claim 4 wherein: the storage means comprises a line in a cache memory having a fixed number of storage locations;

the group of instructions to be executed first is placed at one end of the line in the cache memory, and the instructions in the group to be executed last is placed at the other end of the line in the cache memory.

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6. A method of executing arbitrary numbers of instructions in a stream of instructions in parallel which have been compiled to determine which instructions can be executed at the same time, the method comprising:

10 in response to the compilation assigning group identifiers to sets of instructions which can be executed in parallel;

determining a pipeline for execution of each instruction in a group to be executed;

15 assigning a pipeline identifier to each instruction in the group; and

placing the instructions in a register for execution by the pipelines.

20 7. A method as in claim 6 further comprising the step of executing a group of instructions in parallel.

25 8. A method as in claim 7 wherein the register holds at least two groups of instructions, and the step of placing the instructions in the register for execution by the pipelines comprises placing the instructions in each group having associated therewith a common group identifier adjacent to each other in the register.

30 9. A method as in claim 8 the step of executing a group of instructions in parallel comprises coupling the register to detection means to receive the group identifier of each instruction in the register and the group identifier of the next group of instructions to be supplied to the pipelines; and

35 supplying only the instructions with the next group identifier to the pipeline execution units.

10. In a computing system in which groups of individual instructions are executable in parallel by processing pipelines, a method for supplying each instruction in a group to be executed in parallel to an appropriate pipeline, the method comprising:

storing in storage an instruction frame, the frame including at least one group of instructions to be executed in parallel, each instruction in the group having associated therewith a pipeline identifier indicative of the pipeline which will execute that instruction and a group identifier indicative of the group identification;

comparing the group identifier of each instruction in the instruction frame and a group identifier of those instructions to be next executed in parallel; and

using the pipeline identifier of those instructions to be next executed in parallel to control an execution unit to execute all of the instructions in the group in separate pipelines.

11. In a computing system in which groups of individual instructions are executable in parallel by processing pipelines, apparatus for routing each instruction in a group to be executed in parallel to an appropriate pipeline, the apparatus comprising:

storage for holding at least one group of instructions to be executed in parallel, each instruction in the group having associated therewith a pipeline identifier indicative of the pipeline for executing that instruction and a group identifier to designate among the instructions present in the storage those instructions which may be simultaneously supplied to the processing pipelines.

a crossbar having a first set of connectors coupled to the storage for receiving instructions therefrom and a second set of connectors coupled to the processing pipelines;

means responsive to the pipeline identifier of the individual instructions in the group for routing individual

instructions onto appropriate ones of the second set of connectors, to thereby supply each instruction in the group to be executed in parallel to the appropriate pipeline.

5 12. Apparatus as in claim 11 wherein:

the first set of connectors consists of a set of first communication buses, one for each instruction in the storage;

10 the second set of connectors consists of a set of second communication buses, one for each pipeline; and

the means responsive to the pipeline identifier comprises:

15 a set of decoders coupled to the storage to receive as first input signals the pipeline identifiers and in response thereto supply as output signals a switch control signal; and

20 a set of switches, coupled to the decoders, one switch at the intersection of each of the first set of connectors with the second set of connectors, the switches providing connections in response to receiving the switch control signal to thereby supply each instruction in the group to be executed in parallel to the appropriate pipeline.

25 13. Apparatus as in claim 12 further comprising:

30 detection means coupled to receive the group identifier of each instruction in the storage and connected to receive information regarding the group identifier of the next group of instructions to be supplied to the pipelines, and in response thereto supply a group control signal; and

35 wherein the set of decoders coupled to the storage are also coupled to the detection means to receive the group control signal and in response thereto supplies a switch control signal for only those instructions in the group to be supplied to the pipelines.

14. Apparatus as in claim 13 wherein the detection means comprises a multiplexer coupled to receive each of the group identifiers of instructions in the storage and compare them to the information regarding the group identifier of the next group of instructions to be supplied to the pipelines.

15. Apparatus as in claim 14 wherein the multiplexer supplies an output signal to the decoders to indicate the group identifier of the next group of instructions to be supplied to the pipelines.

16. In a computing system in which groups of individual instructions are executable in parallel by processing pipelines, apparatus for routing each instruction in a group to be executed in parallel to an appropriate pipeline, the apparatus comprising:

a storage for holding an instruction frame, the frame including at least one group of instructions to be executed in parallel, each instruction in the group having associated therewith a pipeline identifier indicative of the pipeline to which that instruction is to be issued and a group identifier indicative of the group identification;

a crossbar switch having a first set of connectors coupled to the storage for receiving instructions therefrom and a second set of connectors coupled to the processing pipelines;

selection means connected to receive the group identification of each instruction in the instruction frame and connected to receive information about the group identifier of those instructions to be next executed in parallel for supplying in response thereto an output signal indicative of the next set of instructions to be executed in parallel; and

decoder means coupled to receive the output signal and each of the pipeline identifiers of the instructions in the storage for selectively connecting ones of the first set

of connectors to ones of the second set of connectors to thereby supply each instruction in the group to be executed in parallel to the appropriate pipeline.

5 17. Apparatus as in claim 16 wherein the first set of connectors consists of a set of first communication buses, one for each instruction in the storage;

 the second set of connectors consists of a set of second communication buses, one for each pipeline;

10 the decoder means comprises a set of decoders coupled to receive as first input signals the pipeline identifiers and as second input signals information about the group identifier of the next group of instructions to be executed by the pipelines and in response thereto supply as
15 output signals a switch control signal; and

 the crossbar switch includes a set of switches, one at the intersection of each of the first set of connectors with the second set of connectors, the switches providing connections in response to receiving the switch
20 control signal to thereby supply each instruction in the group to be executed in parallel to the appropriate pipeline.

25 18. Apparatus as in claim 17 wherein the selection means coupled to the storage comprises a multiplexer coupled to receive each of the group identifiers of instructions in the storage and compare them to information regarding the group identifier of the next group of instructions to be supplied to the pipelines.

30 19. Apparatus as in claim 18 wherein the multiplexer supplies an output signal to the decoders to select the group identifier of the next group of instructions to be supplied to the pipelines.

35 20. In a computing system in which groups of individual instructions are executable in parallel by

processing pipelines, a method for transferring each instruction in a group to be executed through a crossbar switch having a first set of connectors coupled to the storage for receiving instructions therefrom and a second set of connectors coupled to the processing pipelines, the method comprising:

storing in storage at least one group of instructions to be executed in parallel, each instruction in the group having associated therewith a pipeline identifier indicative of the pipeline which will execute that instruction; and

using the pipeline identifiers of the individual instructions in the at least one group of instructions which are to be executed next to control switches between the first set of connectors and the second set of connectors to thereby supply each instruction in the group to be executed in parallel to the appropriate pipeline.

21. A method as in claim 20 wherein the step of using comprises:

supplying the pipeline identifiers of the individual instructions in the at least one group of instructions to a corresponding number of decoders, each of which provides an output signal indicative of the pipeline identifiers; and

using the decoder output signals to control the switches between the first set of connectors and the second set of connectors to thereby supply each instruction in the group to be executed in parallel to the appropriate pipeline.

22. A method as in claim 21 wherein each of the instructions in the storage further includes a group identifier to designate among the instructions present in the storage which may be simultaneously supplied to the processing pipelines, and the method further comprises:

supplying information about the group identifier of the next group of instructions to be executed by the pipelines together with the group identifiers of the individual instructions in the at least one group of instructions to a selector;

comparing the group identifier of the next group of instructions to be executed by the pipelines with the group identifiers of the individual instructions in the at least one group of instructions, to provide output comparison signals; and

using both the output comparison signals and the decoder output signals to control the switches between the first set of connectors and the second set of connectors to thereby supply each instruction in the group to be executed in parallel to the appropriate pipeline.

23. In a computing system in which groups of individual instructions are executable in parallel by processing pipelines, a method for supplying each instruction in a group to be executed in parallel to an appropriate pipeline, the method comprising:

storing in storage an instruction frame, the frame including at least one group of instructions to be executed in parallel, each instruction in the group having associated therewith a pipeline identifier indicative of the pipeline which will execute that instruction and a group identifier indicative of the group identification;

comparing the group identifier of each instruction in the instruction frame and a group identifier of those instructions to be next executed in parallel; and

using the pipeline identifier of those instructions to be next executed in parallel to control switches in a crossbar switch having a first set of connectors coupled to the storage for receiving instructions therefrom and a second set of connectors coupled to the processing pipelines to thereby supply each instruction in

the group to be executed in parallel to the appropriate pipeline.